STUDY OF PRESERVATION TECHNIQUES OF SPINACH

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Abstract*: Spinach is important vegetable product in the minimally processed leafy vegetables industry. It contains 91.4% moisture, 2.2% fiber, 3.6% carbohydrate, 0.4% fat and rich source of vitamin A, iron and calcium. It includes ascorbic acid, carotenoids, anthocyanins, phenols and vitamins. The most part of these compounds are also called phytonutrients because of their beneficial effect. Spinach has a huge demand and is easily perishable commodity which effects the vegetable market around the world, so maintaining quality and extending the shelf life of fresh produce is necessary. The quality parameters of this product is represented by leaf pigments that affect the visual appearance (i.e.texture) and by internal quality components such as ascorbic acid, ethylene, respiration rates , membrane deterioration, water loss, formation of pigments, loss of acidity, tissue softening, enzymatic browning, lipolysis, lipid oxidation, microbiological decay , handling damage , and loss of cellular integrity with a consequential dissipation of cellular fluids, etc. Dehydration and freeze-drying technologies are the commonly used techniques for preserving the leafy vegetables. Also, blanching, dry salting, brining is a prerequisite for some preservation techniques which are used. The shelf life can also be increased by improving the storage and packing by various types of packing's like LDPE bag, plastic punnet, bamboo basket, plastic net bag and storage at temperature ranges between 32-50^0 C or cold storage or vacuum packing and modified atmosphere packing with required precautions. In this project storage experiments are performed on spinach vegetables harvested at commercial stage and storage.

***Keywords*: Shelf life, ascorbic acid, ethylene, respiration rates, perishable, texture**

I. INTRODUCTION

India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2014-15 India produced 86.602 million metric tons of fruits and 169.478 million metric tons of vegetables. The area under cultivation of fruits stood at 6.110 million hectares while vegetables were cultivated at 9.542 million hectares. Though India's share in the global market is still nearly 1% only, there is increasing acceptance of horticulture produce from the country. This has occurred due to concurrent developments in the areas of state-of-the-art cold chain infrastructure and quality assurance measures. The supply of vegetables has increased in all regions of the world, but gaps between food production and access to food, still mean more than 10% of the world population consume less, or none, of what is recommended as the minimum dietary energy requirement. Leaf vegetables, also called potherbs, greens, vegetable greens, leafy greens, or salad greens, are plant leaves eaten as a vegetable, sometimes accompanied by tender petioles and shoots. Although they come from a very wide variety of plants, most share a great deal with other leaf vegetables in nutrition and cooking methods. Leaf vegetables contain many typical plant nutrients, but since they are photosynthetic tissues, their vitamin K levels are particularly notable. Phylloquinone, the most common form of the vitamin, is directly involved in photosynthesis. This causes leaf vegetables to be the primary food class that interacts significantly with the anti-coagulant warfarin. The leafy vegetables have high moisture content therefore highly perishable in nature and therefore have very short shelf life and also seasonal availability limits their utilization all around the world. Hence, there is a need to preserve this nature's store house of nutrients through proper process techniques for safe storage with efficient nutrient retention. Minimally processed leafy vegetables consumption has been increasing in all developed countries. The production and commercialization of these vegetables are very close for their limited shelf life. Usually processing industries for consumer safety limits the commercialization of minimally processed fruits and vegetables to 6-7 days

Spinach is an important leafy vegetable commonly grown in India. It contains 91.4% moisture, 2.2% fiber, 3.6% carbohydrate, 0.4% fat and rich source of vitamin A, iron and calcium. It includes ascorbic acid, carotenoids, anthocyanins, phenols and vitamins. The most part of these compounds are also called phytonutrients because of their beneficial effect. Many nutraceutical compounds are also antioxidants and contribute to establish the antioxidant potential of produces. Maintaining quality and extending the shelf life of fresh produce is necessary. Immature spinach is extremely perishable, having a high rate of respiration and little resistance to water loss. Harvesting should occur when the crop is fully hydrated, cool and dry. Minimizing damage during harvest, and cooling as soon as possible afterwards, will help retain quality. Hydro cooling, hydro-vacuum cooling and forced air systems are all suitable cooling methods. Also post-harvest and nutritional losses occur during handling, transportation, processing and storage, which have gone up to 40 percent annually. Exacerbating the problem of meeting this huge demand for leafy vegetables is the fact that significant production yield decays or spoils before reaching the dinner table of the consumer.

II. SPINACH LEAVES PLANT

Spinach is thought to have originated in ancient Persia (modern Iran and neighboring countries). It is not known by whom, or when, spinach was introduced to India, but the plant was subsequently introduced to ancient China, where it was known as "Persian

vegetable". The earliest available record of the spinach plant was recorded in Chinese, stating it was introduced into China via Nepal . A distinction can be made between older varieties of spinach and more modern ones. Older varieties tend to bolt too early in warm conditions. Newer varieties tend to grow more rapidly but have less of an inclination to run up to seed. The older varieties have narrower leaves and tend to have a stronger and more bitter taste. Most newer varieties have broader leaves and round seeds. The three basic types of spinach are: Savoy has dark green, crinkly and curly leaves. It is the type sold in fresh bunches in most supermarkets in the United States. One heirloom variety of savoy is Bloomsdale, which is somewhat resistant to bolting. Other common heirloom varieties are Merlo Nero (a mild variety from Italy) and Viroflay (a very large spinach with great yields).Flat- or smooth-leaf spinach has broad, smooth leaves that are easier to clean than Savoy. This type is often grown for canned and frozen spinach, as well as soups, baby foods, and processed foods. Giant Noble is an example variety. Semi-savoy is a hybrid variety with slightly crinkled leaves. It has the same texture as Savoy, but it is not as difficult to clean. It is grown for both fresh market and processing. Tyee Hybrid is a common semi-savoy.

Raw spinach is 91% water, 4% carbohydrates, 3% protein, and contains negligible fat (table). In a 100 g serving providing only 23 calories, spinach has a high nutritional value, especially when fresh, frozen, steamed, or quickly boiled. It is a rich source of vitamin A, vitamin C, vitamin K, magnesium, manganese, iron and folate (table). Spinach is a good source of the B vitamins riboflavin and vitamin B_6, vitamin E, calcium, potassium, and dietary fiber. Spinach, along with other green, leafy vegetables, contains an appreciable amount of iron attaining 21% of the Daily Value in a 100 g amount of raw spinach. However, spinach contains iron absorption-inhibiting substances, including high levels of oxalate, which can bind to the iron to form ferrous oxalate and render much of the iron in spinach unusable by the body. In addition to preventing absorption and use, high levels of oxalates remove iron from the body. Spinach also has a moderate calcium content which can be affected by oxalates, decreasing its absorption. The calcium in spinach is among the least bioavailable of food calcium sources. By way of comparison, the human body can absorb about half of the calcium present in broccoli, yet only around 5% of the calcium in spinach.

III. METHODOLOGY FOR PRESERVATION

Preservation is based firstly on the delay or prevention of microbial growth. It must therefore operate through those factors that most effectively influence the growth and survival of microorganisms. The preservation can be done either by drying or preserving it fresh or naturally without drying.

A. ESSENTIAL OILS

Bio preservatives, a wide range of natural products from both plants and microorganisms, can be useful in extending the shelf life of foods, reducing or eliminating pathogenic bacteria, and increasing overall quality of food products. The effectiveness of essential oil application in foods is the result of factor associations such as composition and storage temperatures. The application methods (spray, immersion, and embedded in lactose capsules) and the concentration of essential oils have been shown to be important factors in determining the effectiveness of these bio preservatives. The presence of surfactants and organic substances that interact with active sites of the antimicrobial substances also plays an important role. In addition, the mode that essential oils were applied on foods is fundamental to antibacterial and antioxidant activity. A number of potential synergic factors have been suggested for use with essential oils such as reducing pH, adding organic acids, low reducing oxygen tension using modified atmospheres, applying mild heat shocks and so on. Types of essential oils that can be used lemon (Citrus limonum), rosemary (Rosmarinus officinalis), tea tree (Melaleuca alternifolia) and clove (Syzygium aromaticum)

Preparation:

Raw spinach leaves were washed, steam blanched for 2 min and shredded and note down the final compositions like water contents, proteins and total fats.

Procedure:

- Apply essential oil (any one or combination) to the blanched spinach at one, two and three times the minimal inhibitory concentration (MIC).
- One hundred grams of spinach is thoroughly mixed with the essential oils and immediately inoculated with active cultures of E.coli (Escherichia coli) strain O_{157}:H_7 reaching a pathogen concentration of approximately 106 cfu/ml.
- The active culture and the food samples are mixed together.
- Store the inoculated food samples for 24h at 8–10^{0}C (representing an inadequate refrigeration storage) and at 20–22 ^{0}C (representing an inadequate room temperature).

B. VACUUM PACKING

This method involves placing the spinach leaves in aplastic film packaging , removing air inside the bag and sealing the package . It is also called Reduced Oxygen Packing. The purpose of this method is to preserve the quality of spinach for as long as possible and to ensure that the taste method is to preserve the quality of spinach for as long as possible. The advantages of this method is that it is more convenient and economical over the other.

C. MODIFIED ATMOSPHERE PACKING

The objective of packaging is to create an atmosphere inside the packaging an appropriately balanced gas composition, which would enabled the greatest possible reduction in the physiological activity of the product. Currently the food industry uses packages that

are nondegradable, generating environmental problems. Several biopolymers have been exploited to develop materials for ecofriendly food packaging, however their poor mechanical and barrier properties have limited their use.
Spinach leaves, after sorting and removal of leaf stalks, are washed in cold running water. After being drained they are immersed in a mixture of ascorbic acid (0.5%) and citric acid (0.5%) (solutions temperature 6°C), for approx. 10 min, then drained and dried on blotting paper. Next, the leaves are chopped into fragments of approx. 2 cm x 2 cm, packaged and stored at 4°C (in a refrigerator) for 12 days.
The minimally processed product is packaged in batches of 30 g in packages made of plastic laminate: oriented polyamide/polyethylene with layer thickness of 50/40 µg, of 15 x 21 cm and gas permeability (in cm3/m2/24 h at 23°C): carbon dioxide – 200, oxygen – 45 (water vapour: 2-3 g/m2/24 h), and sealed using an A 300 vacuum packaging machine by Multivac. In the packaging of spinach atmosphere variants with composition 10% oxygen/10% carbon dioxide/80% nitrogen are used.

IV. CONCLUSIONS

Spinach and other leafy vegetables has a huge demand and is easily perishable commodity which effects the vegetable market around the world ,so maintaining quality and extending the shelf life of fresh produce is necessary. The quality parameters of this product is represented by leaf pigments that affect the visual appearance (i.e. texture) and by internal quality components such as ascorbic acid, ethylene, respiration rates, membrane deterioration, water loss, formation of pigments, loss of acidity, tissue softening , enzymatic browning, lipolysis, lipid oxidation, microbiological decay , handling damage , and loss of cellular integrity with a consequential dissipation of cellular fluids, etc. Here we have studied the various methods of preservation of spinach and we can say that temperature is the single biggest factor in postharvest quality of vegetables. The temperature of produce drives water loss, changes in metabolic activity, loss of flavour, texture and nutrients and the development of roots. From the above study of experiments performed we can conclude that the preservation of spinach can be done more effectively by focusing on the packaging part. It is seen that vaccum packing and punnet packing as well as modified atmosphere packing are effective in good preservation of spinach. The vaccum packing method is more feasible as it is less expensive and more economical and the samples lasted for 14 days than any other preservation technique. The modified atmosphere packing is also an effective method and can be commercialized but is expensive and needs proper handling. Also the use of any chemicals should be avoided as it can cause harm to the texture, appearance and nutritive values of the vegetable making it difficult to consume.

Preservation techniques is a vast area to study the effect of post harvest losses of leafy vegetables on its shelf life and to prevent its damage and to meet the consumers demand for healthy, additive-free, microbiologically safe and high quality vegetables. The evolution of food preservation over the years has been subsistence. But there is still lack of information about the actual critical points of the industrial fresh processing chain and on the current and feasible technologies to successfully preserve the vegetable products. Preventing the growth of bacteria ,fungi, and other micro-organisms for the sake of storing food can be achieved through many diverse methods. Processeas simple as drying and salting have evolved into more modern techniques such as irrudation and high pressure food preservation.. Further enhancements can be made by emphasizing on the material of packing and the impact of each packaging material on the product. Looking into the future, high pressure preservation seems to be the next logical step.

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